Hx8 Series
HA8 / HB8

User Manual

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Compliance Information

Compliance information for this product is available at http://www.digium.com/ccs-compliance.

Introduction to Hx8 Series Documentation

This manual contains product information for the Hx8 Series card. Be sure to refer to any supplementary documents or release notes that were shipped with your equipment. The manual is organized in the following manner:

Chapter/ Appendix	Title	Description
1	Overview	Identifies the card and type of modules you received with your Hx8 Series card. This chapter covers applications and uses of the Hx8 Series card in the real world.
2	Card Installation	Provides instructions for installing the card in your PC, acquiring correct drivers, and checking device compatibility.
3	Configuration	Provides examples for configuring dial plan options.
4	FXS, FXO, and BRI Explained	Describes the FXO (Foreign Exchange Office), FXS (Foreign Exchange Station), and BRI (Basic Rate ISDN) modules and their significance.
5	Troubleshooting	Explains resolutions to common problems and frequently asked questions pertaining to card installation and usage.
A	Pin Assignments	Lists the connectors and pin assignments.
B	Specifications	Details card specifications.
C	Glossary and Acronyms	Defines terms related to this product.

Symbol Definitions

Caution statements indicate a condition where damage to the unit or its configuration could occur if operational procedures are not followed. To reduce the risk of damage or injury, follow all steps or procedures as instructed.

The ESD symbol indicates electrostatic sensitive devices. Observe precautions for handling devices. Wear a properly grounded electrostatic discharge (ESD) wrist strap while handling the device.

The Electrical Hazard Symbol indicates a possibility of electrical shock when operating this unit in certain situations. To reduce the risk of damage or injury, follow all steps or procedures as instructed.

Important Safety Instructions

User Cautions

Warning

This card must be used with the PC lid screwed down. Telecommunications network voltages exist inside the PC! The PC must be shut down and telecommunications line connection shall be removed before opening the PC.

Electrical Shock

To reduce the risk of injury, damage to the unit or your equipment, do not attempt to touch the modules while they are powered. The case should be securely closed before power is applied to the unit.

Alarm Dialing Equipment

If your home has specially wired alarm equipment connected to the telephone line, ensure the installation of the Hx8 Series does not disable your alarm equipment. If you have questions, consult your telephone company or a qualified installer.

Servicing

Do not attempt to service this card unless specifically instructed to do so. Do not attempt to remove the card from your equipment while power is present. Refer servicing to qualified service personnel.

Water and Moisture

Do not spill liquids on this unit. Do not operate this equipment in a wet environment.

Heat

Do not operate or store this product near heat sources such as radiators, air ducts, areas subject to direct, intense sunlight, or other products that produce heat.

Caution

To reduce the risk of fire, use only No. 26 AWG or larger telecommunication wiring for network connections.

User Cautions

Caution
This card is not intended for home use. It must be used in restricted access locations and installed in UL Listed I.T.E. only.

Static Electricity
To reduce the risk of damaging the unit or your equipment, do not attempt to open the enclosure or gain access to areas where you are not instructed to do so. Refer servicing to qualified service personnel.

Save these instructions for future reference.

Service Personnel Cautions

Warning
This card must be used with the PC lid screwed down.
Telecommunications network voltages exist inside the PC!
The PC must be shut down and telecommunications line connection shall be removed before opening the PC.

Electrical Shock
To reduce the risk of injury, damage to the unit or your equipment, do not attempt to touch the modules while they are powered. The case should be securely closed before power is applied to the unit.

Servicing
Disconnect telecommunications network cable before opening the cover or removing the card from the motherboard.

Labeling
For safety reasons, only connect equipment with a Telecommunications Compliance label. This includes customer equipment previously labelled **Permitted** *or* **Certified.**

Caution
Only connect regulatory equipment (approved for use in your specific country) to the telecommunications network voltage circuit ports.

Service Personnel Cautions

Caution

This card is not intended for home use. It must be used in restricted access locations and installed in UL Listed I.T.E. only.

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Chapter 1
Overview

The Hx8 Series cards are versatile devices used for connecting your phone network to the PSTN (Public Switched Telephone Network) world. This is accomplished through analog lines connected to the FXO (Foreign Exchange Office) ports, digital lines connected to the BRI (Basic Rate ISDN) ports, and phone handsets connected to the FXS (Foreign Exchange Station) ports. The Hx8 Series cards allow Asterisk to connect to your phone network, creating an office type telephony environment. In addition, they can also improve voice quality in environments where software echo cancellation is not sufficient by using hardware echo cancellation on board.

> **Note:** An FXO module cannot be used in combination with a BRI module that is taking timing in TE mode on the same Hx8 Series card. An FXO module can be used in combination with a BRI module that is providing timing in NT mode on the same Hx8 Series card.

The Digium BRI module is compatible with Euro-ISDN. It is capable of serving as a Terminal Equipment (TE) and/or Network Termination (NT) device. When configured as an NT device, it is the source of BRI lines as shown in Figure 1 and Figure 2.

> **Note:** The Hx8 Series cards do not support North American BRI.

There are a variety of applications where the Hx8 Series cards (HA8 or HB8) can prove useful. Examples are provided in the following figures.

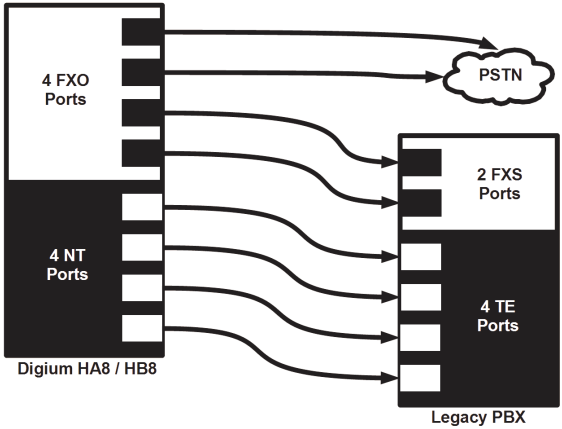


Figure 1: Sample Card Application for FXO / BRI

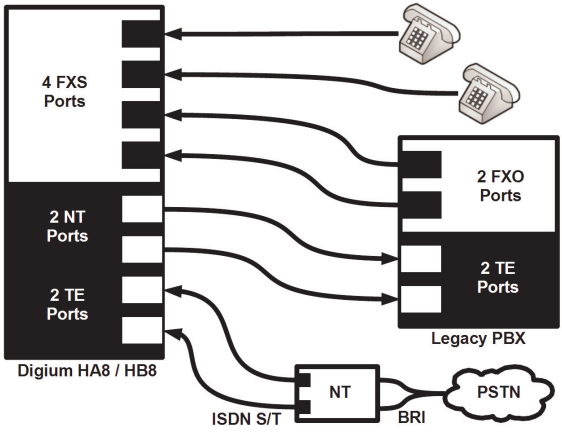


Figure 2: Sample Card Application for FXS / BRI

Note: An FXS module should be connected only to a device that is located inside of the same building to minimize lightning exposure.

Echo-Cancellation

Users connecting their Hx8 Series cards to the PSTN or other devices are likely to be placing calls that will result, at some point, in an unbalanced 4-wire/2-wire hybrid. The result of this hybrid is the reflection of a near-end echo to the calling party. Elimination of this echo is the responsibility of echo cancellation.

The Hx8 Series cards, unless otherwise equipped, utilize Asterisk to perform software-based echo cancellation. Asterisk maintains a number of open source echo cancellers. These open source echo cancellers provide a moderate level of echo cancellation, but are not capable of dealing with higher levels of, or more advanced, echoes.

Digium recommends that those users concerned about echo cancellation purchase the VPMOCT032 hardware echo cancellation module. The VPMOCT032 may be combined with both the HA8 and HB8.

The VPMOCT032 is designed to handle up to 128ms of echo cancellation across all channels and provides a G.168 echo cancellation solution.

What is Asterisk®?

Asterisk is the world's leading open source telephony engine and tool kit. Offering flexibility unheard of in the world of proprietary communications, Asterisk empowers developers and integrators to create advanced communication solutions...for free. Asterisk is released as open source under the GNU General Public License (GPL), and it is available for download free of charge. Asterisk is the most popular open source telephony software available, with the Asterisk Community being the top influencer in VoIP.

Asterisk as a Phone Switch (PBX)

Asterisk can be configured as the core of an IP or hybrid PBX, switching calls, managing routes, enabling features, and connecting callers with the outside world over IP, analog (POTS), and digital (T1/E1/J1/BRI) connections.

Asterisk runs on a wide variety of operating systems including Linux, Mac OS X, OpenBSD, FreeBSD, and Sun Solaris. It provides all of the features you would expect from a PBX including many advanced features that are often associated with high end (and high cost) proprietary PBXs. Asterisk's architecture is designed for maximum flexibility and supports Voice over IP in many protocols, and can interoperate with almost all standards-based telephony equipment using relatively inexpensive hardware.

Asterisk as a Gateway

It can also be built out as the heart of a media gateway, bridging the legacy PSTN to the expanding world of IP telephony. Asterisk's modular

architecture allows it to convert between a wide range of communications protocols and media codecs.

Asterisk as a Feature/Media Server

Need an IVR? Asterisk's got you covered. How about a conference bridge? Yep. It's in there. What about an automated attendant? Asterisk does that too. How about a replacement for your aging legacy voicemail system? Can do. Unified messaging? No problem. Need a telephony interface for your web site? Okay.

Asterisk in the Call Center

Asterisk has been adopted by call centers around the world based on its flexibility. Call center and contact center developers have built complete ACD systems based on Asterisk. Asterisk has also added new life to existing call center solutions by adding remote IP agent capabilities, advanced skills-based routing, predictive and bulk dialing, and more.

Asterisk in the Network

Internet Telephony Service Providers (ITSPs), Competitive Local Exchange Carriers (CLECs) and even first-tier incumbents have discovered the power of open source communications with Asterisk. Feature servers, hosted services clusters, voicemail systems, and pre-paid calling solutions, all based on Asterisk have helped reduce costs and enabled flexibility.

Asterisk Everywhere

Asterisk has become the basis for thousands of communications solutions. If you need to communicate, Asterisk is your answer. For more information on Asterisk, visit http://www.asterisk.org or http://www.digium.com.

Chapter 2
Card Installation

This chapter provides the following information:

- **Unpacking the Card** on page 22
- **Shipment Inspection** on page 23
- **Module Identification** on page 23
- **Port Identification** on page 24
- **Applying a Port Identification Label** on page 29
- **Card Identification** on page 30
- **Slot Compatibility** on page 34
- **Hardware Installation** on page 36
- **Connecting a Timing Cable** on page 40
- **FXO, FXS, and BRI Connection** on page 41
- **Software Installation** on page 42
- **Installing Asterisk** on page 46

Note: The Hx8 Series card installation instructions are written so that they will apply to any card in the series. Examples and card specific information are included as needed.

Unpacking the Card

When you unpack your card, carefully inspect it for any damage that may have occurred in shipment. If damage is suspected, file a claim with the carrier and contact the reseller from which the card was purchased. If the card was purchased direct from Digium, contact Digium Technical Support at +1.256.428.6161. Keep the original shipping container to use for future shipment or proof of damage during shipment.

Note: Only qualified service personnel should install the card. Users should not attempt to perform this function themselves. The installer must ensure that the equipment is permanently connected equipment, pluggable type B or connected to a socket-outlet that has been checked to ensure that it is reliably earthed in accordance with the National Electrical Code.

This card is intended for installation in a Restricted Access Location (RAL) only.

Shipment Inspection

The following items are included in shipment of an Hx8 Series card:

- Hx8 Series card (HA8 or HB8)
- FXO, FXS, and/or BRI module(s), depending on configuration
- 4 or 8 Digium BRI RJ11-to-RJ45 cables for BRI configurations only
- Port identification labels

Note: After inspecting the shipment, Digium highly recommends that you register the card for support eligibility. Please refer to **Free Installation Support** on page 87 for additional information on how to obtain assistance from Digium Technical Support.

Module Identification

The Hx8 Series cards ship with FXO, FXS, and/or BRI modules in place. These are identified by their color. Take a moment to identify which modules were shipped with your card.

- FXO (Foreign Exchange Office) modules are Red
- FXS (Foreign Exchange Station) modules are Green
- BRI (Basic Rate ISDN) modules are Blue

The Hx8 Series cards may also be combined with Digium's hardware-based echo canceller, model VPMOCT032. See Figure 5 on page 27 for an example of the HA8 card shown with the echo cancellation module.

Port Identification

Each card consists of eight RJ11 ports located on the bracket. Each RJ11 port correlates to a single FXO or FXS channel, or to a single BRI span. The ports are numbered in sequence from one to eight. The top port is Port 1 and the bottom port is Port 8. See Figure 3 on page 25 for appropriate identification of these ports. The port identification is the same for all cards in this series.

It is important to identify the type and location of your Hx8 Series modules. You will need this information during the Asterisk configuration.

The ports available for use on the Hx8 Series cards are not continuous. The ports available for use depend upon the type of module used, and the placement of the module on the card. The cards can accept 2 quad modules, for a total of 8 ports. If single modules are used, only 2 single modules can occupy the same space as a quad module. The single module ports are identified on the card and their corresponding RJ11 ports are identified below. Please refer to Figure 5 on page 27 for an example using a single module, and Figure 6 on page 28 for an example using quad modules.

If a single module is used, the RJ11 port available for use will be the port corresponding to the location of the module on the card. The following ports correspond to the single module ports as shown in Figure 3.

- RJ11 Port 1 is used by Single Module Port 1
- RJ11 Port 2 is used by Single Module Port 2
- RJ11 Port 5 is used by Single Module Port 5
- RJ11 Port 6 is used by Single Module Port 6

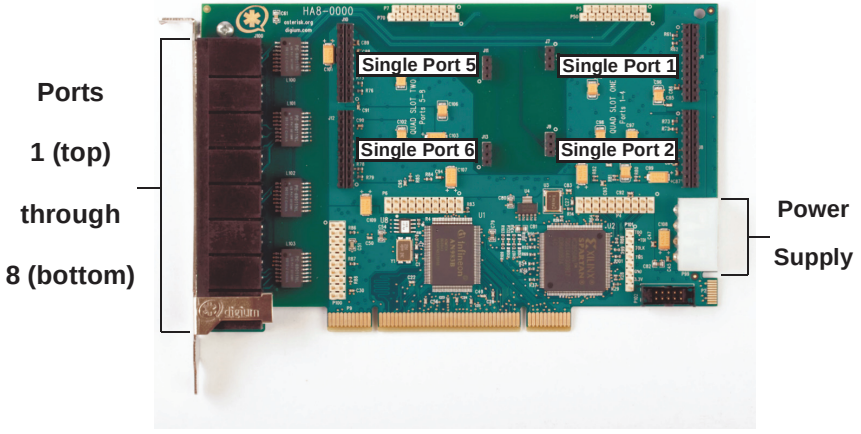


Figure 3: HA8 Base Card with Single Port Identification

Figure 4: HA8 Base Card with Quad Port Identification

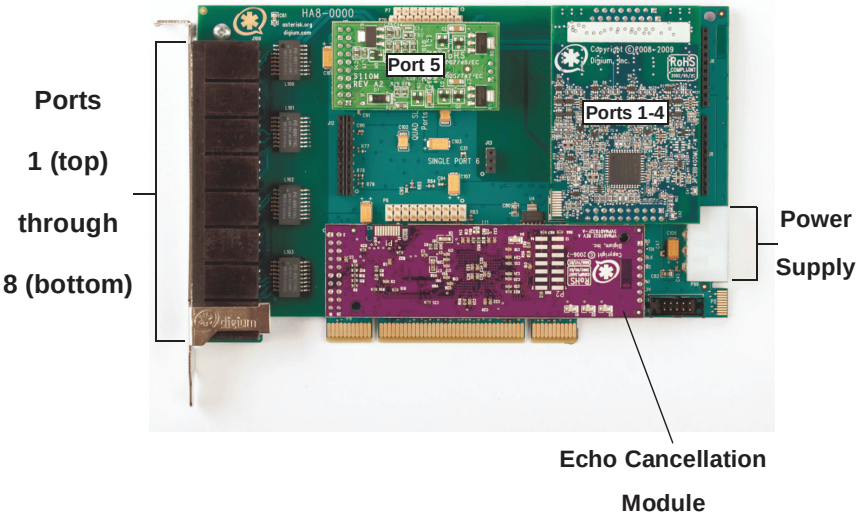


Figure 5: HA8 Bundle with Single Module and Quad Module

If a quad module is placed covering single module ports 1 and 2, then that module will use ports 1-4. Likewise, if a quad module is placed covering single module ports 5 and 6, the module will use ports 5 through 8. Figure 6 shows a HA8 card with two quad modules.

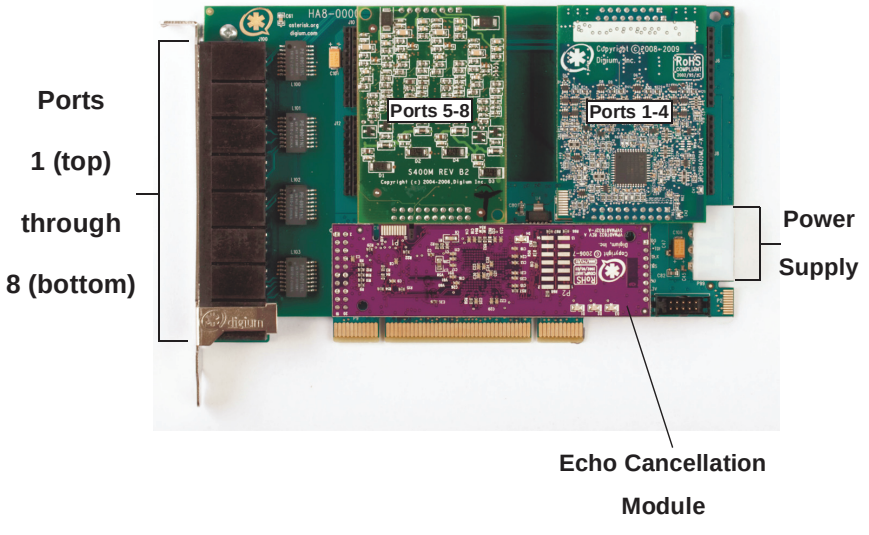


Figure 6: HA8 Bundle with 2 Quad Modules

Applying a Port Identification Label

Once you have identified the ports of the Hx8 Series card, you should apply a port identification label. This is important in order to ensure that only compatible devices are connected to the ports of the Hx8 Series card. It is highly recommended that you apply the label in a clearly visible location near the external port connectors.

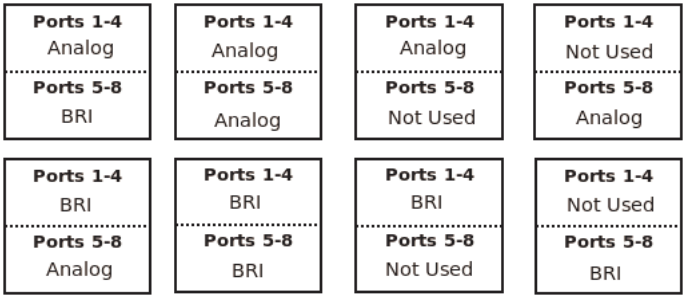


Figure 7: Example Port Identification Labels

Note: The port identification labels packaged with an Hx8 Series card may differ from this example.

Card Identification

There are multiple configurations in which an Hx8 Series card may be purchased. Each configuration consists of a combination of single modules, quad modules, or both, and may also include the VPMOCT032 echo cancellation module. See Table 1 on page 30 for a list of the most common HA8 configurations. See Table 2 on page 32 for a list of the most common HB8 configurations. The lists are not complete, but rather an example of some of the configurations available.

It is easiest to identify your card by understanding the naming scheme for each card. The first digit is the maximum port count of the card. The second digit is reserved for future use. The third digit is the number of BRI ports present on the card. The fourth digit is the number of FXS ports present on the card. The fifth digit is the number of FXO ports present on the card. An “S” in place of the fourth digit signifies the use of single FXS modules. An “S” in place of the fifth digit signifies the use of single FXO modules. A “B” at the end signifies the use of a hardware echo cancellation module.

Table 1: Example HA8 Bundles

Card ID	Ports
HA8-0001	1 Single FXO module without hardware echo cancellation
HA8-00S4	4 Single FXO modules without hardware echo cancellation
HA8-0004	1 Quad FXO module without hardware echo cancellation

Table 1: Example HA8 Bundles (continued)

Card ID	Ports
HA8-0008B	2 Quad FXO modules with hardware echo cancellation
HA8-0010	1 Single FXS module without hardware echo cancellation
HA8-004S	4 Single FXS modules without hardware echo cancellation
HA8-0040	1 Quad FXS module without hardware echo cancellation
HA8-0080B	2 Quad FXS modules with hardware echo cancellation
HA8-0044B	1 Quad FXS and 1 Quad FXO module with hardware echo cancellation
HA8-0400B	1 BRI module with hardware echo cancellation
HA8-0800B	2 BRI modules with hardware echo cancellation
HA8-0440B	1 BRI and 1 Quad FXS module with hardware echo cancellation

Table 2: Example HB8 Bundles

Card ID	Ports
HB8-0001	1 Single FXO module without hardware echo cancellation
HB8-00S4	4 Single FXO modules without hardware echo cancellation
HB8-0004	1 Quad FXO module without hardware echo cancellation
HB8-0008B	2 Quad FXO modules with hardware echo cancellation
HB8-0010	1 Single FXS module without hardware echo cancellation
HB8-004S	4 Single FXS modules without hardware echo cancellation
HB8-0040	1 Quad FXS module without hardware echo cancellation
HB8-0080B	2 Quad FXS modules with hardware echo cancellation
HB8-0044B	1 Quad FXS and 1 Quad FXO module with hardware echo cancellation
HB8-0400B	1 BRI module with hardware echo cancellation

Table 2: Example HB8 Bundles (continued)

Card ID	Ports
HB8-0800B	2 BRI modules with hardware echo cancellation
HB8-0440B	1 BRI and 1 Quad FXS module with hardware echo cancellation

Caution
Only qualified service personnel should continue with hardware installation and configuration of the Hx8 Series card. Users should not attempt to perform these functions themselves.

Slot Compatibility

Check the slots on your motherboard to verify that you have a slot available which is compatible with the Hx8 Series cards. To determine which slots you have on your motherboard, identify them by comparing them to those shown in Figure 8.

Slot Number:

0: AGP Pro Slot
1: 64-bit 5.0 volt PCI Slot
2: 64-bit 3.3 volt PCI Slot
3: 32-bit 5.0 volt PCI Slot
4: PCI Express 1-lane (x1) Slot
5: PCI Express 4-lane (x4) Slot
6: PCI Express 8-lane (x8) Slot
7: PCI Express 16-lane (x16) Slot

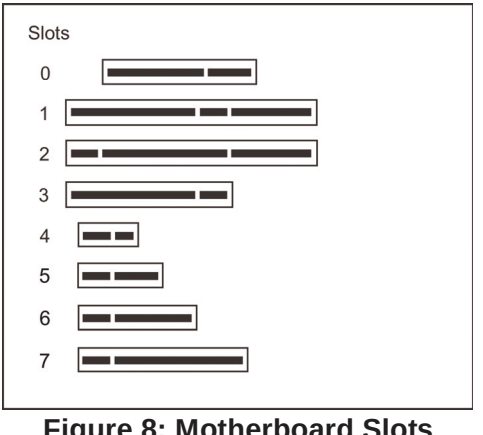


Figure 8: Motherboard Slots

The HA8 card is a 32-bit 33 MHz card keyed for universal 3.3 volt or 5.0 volt operation and works in any PCI 2.2 (or greater) compliant slot. This means that in the motherboard shown in Figure 8, the HA8 card will fit into Slots 1, 2, or 3 (PCI slots), but **cannot** fit into any of the other slots.

The HB8 card is keyed for a PCI Express 1-lane (x1) slot and will work in any PCIe revision 1.0 compliant slot, including lane lengths x4, x8, and x16. This means that in the motherboard shown in Figure 8, the HB8 card will fit into Slots 4, 5, 6, or 7 (PCI Express), but **cannot** fit into any of the other slots.

Hardware Installation

1. Now that you are acquainted with your card, power down your computer, and unplug it from its power source.
2. Attach an anti-static strap to your wrist and open the case.
3. Remove the bracket place holder and insert the card into a PCI (HA8) or PCI Express (HB8) slot. See Figure 9.

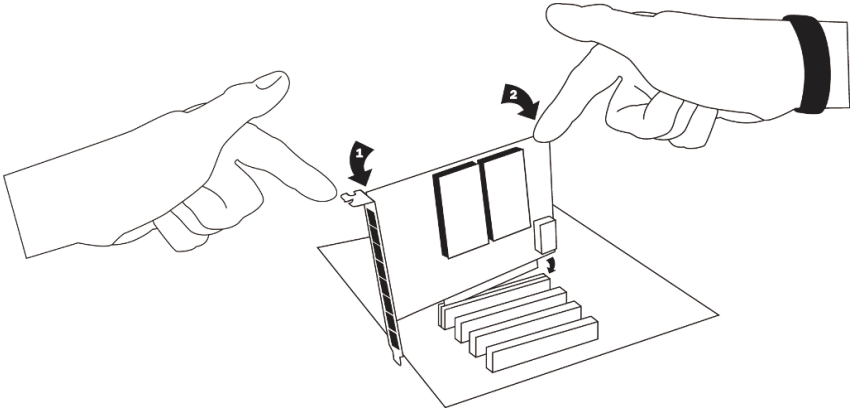


Figure 9: Insert the Card

4. If your card has any FXS modules, you will also need to connect the power cable from your computer's power supply to the back of the card. Insert a four-pin 12 volt connector (disk drive power supply cable, e.g. hard drive) into the white plastic connector on the rear of the card. See Figure 10.

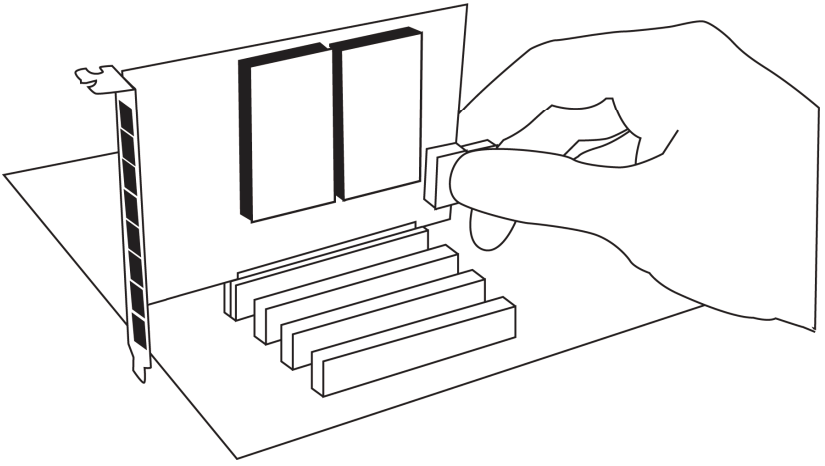


Figure 10: Connect Power for FXS Modules

Many modern PCs and servers do not have either spare or any 12V power connectors. If you have FXS modules on your card and your computer does not have power cables available, then power must be provided to the Hx8 Series card by an alternate means. Digium provides a solution to this issue with the optional PWR2400B (available separately). The PWR2400B card is essentially a PCI bracket assembly that takes power from an external DC power supply and routes it to two 15" power cables inside the computer. You must have an available bracket slot to use the PWR2400B (either PCI, PCI Express or AGP).

A strap on the PWR2400B card allows the two power cables to take power from the same DC supply. The PWR2400B comes with one power supply capable of supporting up to 24 FXS ports, driving heavy loads of up to 5REN per port. If more than 24 FXS ports with heavy loads are connected to the PWR2400B, then a second Digium power supply should

be purchased. The shorting strap on the PWR2400B should be removed if a second power supply is used.

The PWR2400B does not connect to any bus inside the computer. It may be used wherever there is an available PCI-size bracket such as a PCI, PCI Express, or AGP slot.

Note: The PWR2400B is not intended to supply power to any other device, it is intended only to be used with UL Listed Digium analog-capable cards.

5. Replace the cover to your computer.

Electrical Shock
To reduce the risk of injury, damage to the unit or your equipment, do not attempt to apply power to the unit while the case is open.Personal injury or damage to the unit could occur if the modules are touched while powered is applied.

6. Plug all analog telephone lines to the FXO ports (corresponding to the red modules) and all analog phones to the FXS ports (green modules) as needed using a patch panel, punch block, or standard RJ11 telephone cables. Then plug all BRI lines or externally powered ISDN phones to the BRI (blue) ports using a patch panel, punch block, or the provided Digium BRI RJ11-to-RJ45 cables. Refer to the pin assignments starting on page 88.

Caution
This unit must be connected to the Telecommunications Network in your country using an approved line cord, e.g.: for Australia use only line cords complying with AS/CA S008:2010.

Caution

Only connect regulatory equipment (approved for use in your specific country) to the telecommunications network voltage circuit ports.

Connecting a Timing Cable

The timing port allows up to three Hx8 Series cards to share the same sync (timing) source from the BRI line provider, or provide a consistent sync source across multiple cards. This is a useful feature for fax modes and some voice applications to prevent corruption due to timing slips on the second and third Hx8 Series cards.

To utilize this feature, daisy-chain the P102 connector between each Hx8 Series card using the Digium 3-position, 10-pin timing cable. Enable this feature by using the **timingcable=1** kernel module parameter when the driver is loaded:

```
# modprobe wctdm24xxp timingcable=1
```

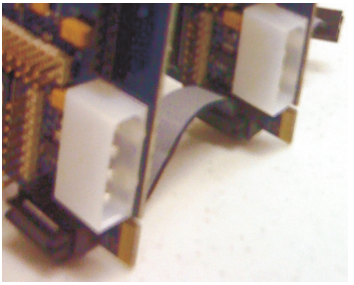


Figure 11: Timing Cable Connection

FXO, FXS, and BRI Connection

The Hx8 Series cards provide eight RJ11 connectors for access to the FXS, FXO, and BRI modules installed in the available slots. Using a standard RJ11 telephone cable, an analog telephone line should be plugged into one of the RJ11 connectors associated with an FXO module on the Hx8 Series card. Using a standard RJ11 telephone cable, an analog phone should be plugged into one of the RJ11 connectors associated with an FXS module on the Hx8 Series card. Using a Digium BRI RJ11-to-RJ45 cable, a digital BRI line or externally powered ISDN phone should be plugged into one of the RJ11 connectors associated with a BRI module on the Hx8 Series card. Refer to the pin assignments starting on page 88.

Software Installation

Digium hardware requires drivers and libraries that are not integrated with the Linux kernel. Digium hardware is only supported under Linux. Digium recommends CentOS, Debian, Red Hat, and Ubuntu distributions of Linux. However, many other distributions are supported by Digium Technical Support.

Digium's software, including drivers and application software, may be obtained from Digium's download servers at:
http://downloads.digium.com
http://downloads.asterisk.org

For an introduction to Asterisk, Digium's telephony software, including additional information on its configuration, setup, and features, please refer to:
http://www.asterisk.org

For the latest information on setting up and configuring DAHDI drivers for your Digium hardware product, please refer to the latest release of this manual which is available from the product-specific documentation section at:
http://www.digium.com

To install your Hx8 Series card, you will need:

- Linux 2.6 kernel headers
- Development libraries and headers for ncurses
- Development libraries and headers for zlib and openssl
- Development libraries and headers for newt
- GCC and standard software build tools

It is recommended that you use the most recent version of the Asterisk, DAHDI, and libpri software for the best results. If you have previously installed any of these, Digium recommends that you upgrade to the latest "-current" version of each.

Note: The Hx8 Series cards' minimum version requirements are Asterisk 1.6.0.1, DAHDI Linux 2.3.0, DAHDI Tools 2.3.0, and libpri 1.4.10.2.

1. After the machine has booted to Linux, log in and execute the following command to list the devices detected by the PCI bus:

```
# lspci -n
```

Confirm that the output from **lspci** lists a device with Digium's PCI vendor ID which is "d161". The screen output should be similar to the following:

```
00:0a.0 0200: d161:<card identifier> (rev 01)
```

Note: The output from **lspci** may or may not state "Unknown device". If it does, this does not indicate a problem.

In the PCI device listing shown above, <card identifier> will be populated with one of the identifiers listed in the table below.

Table 3: Card Identifiers

Model	Identifier
HA8 HB8	8007 8008

A Digium Hx8 Series (HA8 / HB8) card identifier should be listed. If a matching card identifier is not listed, then your machine is not PCI 2.2 (or higher) or PCI Express compatible, and the card will not work with your motherboard.

2. Download the latest version of libpri. Substitute the version of libpri for the X.X in the command line below. libpri is available for download from:
http://downloads.asterisk.org/pub/telephony/libpri

```
# wget http://downloads.asterisk.org/pub/telephony/
libpri/libpri-X.X-current.tar.gz
```

Note: There is no correlation between the versioning of libpri and Asterisk. The libpri 1.4 branch will function with the Asterisk 1.6 and 1.8 branches.

3. Expand the downloaded file, compile its contents, and install the libraries. Substitute the version of libpri for the X.X and X.X.X.X in

the command lines below.

```
# tar -zxvf libpri-X.X-current.tar.gz
# cd libpri-X.X.X.X/
# make
# make install
```

4. Download the latest DAHDI drivers with tools. DAHDI is available for download from: http://downloads.asterisk.org/pub/telephony/dahdi-linux-complete

```
# wget http://downloads.asterisk.org/pub/telephony/
dahdi-linux-complete/dahdi-linux-complete-
current.tar.gz
```

5. Expand the downloaded file, compile its contents, and install the drivers and tools. Substitute the version of DAHDI for the X.X.X in the command lines below.

```
# tar -zxvf dahdi-linux-complete-current.tar.gz
# cd dahdi-linux-complete-X.X.X+X.X.X
# make
# make install
# make config
```

Note: Executing 'make config' will install an init script and symlinks which will allow you to start and stop DAHDI as a service.

Installing Asterisk

If you wish to use Asterisk with your new hardware, you can follow the instructions below.

1. Download the latest release version of Asterisk. Substitute the version of Asterisk for the X.X.X in the command below. Asterisk is available for download from: http://downloads.asterisk.org/pub/telephony/asterisk

```
# wget http://downloads.asterisk.org/pub/telephony/
asterisk/asterisk-X.X.X-current.tar.gz
```

2. Expand the downloaded file, compile its contents, and install the application. Substitute the version of Asterisk for the X.X.X and X.X.X.X in the command lines below.

```
# tar -zxvf asterisk-X.X.X-current.tar.gz
# cd asterisk-X.X.X.X/
# ./configure
# make menuselect
# make
# make install
```

3. If this is the first Asterisk installation on this system, you should install the sample configuration files. To do this, run:

```
# make samples
```

Note: Running this command will overwrite, after making a backup copy, any older Asterisk configuration files that you have in the /etc/asterisk directory.

If your installation has failed, it may be because you are missing one or more of the build dependencies, the kernel headers, or the development tools. Contact your reseller where the card was purchased, or call Digium Technical Support at +1.256.428.6161 for assistance. Please refer to **Free Installation Support** on page 87 for additional information on how to obtain assistance from Digium Technical Support.

Complete instructions for installing Asterisk are available at www.asterisk.org.

Chapter 3
Configuration

The Hx8 Series cards have a variety of configuration options. This chapter provides sample configurations to demonstrate customizing the Asterisk software to meet your individual needs. Each section explains basic options as examples. Once you have familiarized yourself with the samples, you can edit the configuration files to meet your specific needs.

Understanding Span and Channel Assignments

In order to properly configure your Hx8 Series card, it is important to understand how spans and channels are assigned to the card in software. A span is a group of channels that is bundled together in software. Depending on how an Hx8 Series card is configured, it can have one analog span, four digital spans, eight digital spans, or one analog span and four digital spans. The following bulleted lists provide important information regarding analog and digital spans.

- **Analog Span for FXO/FXS**
  - The analog span will not exist if there are no analog modules installed.
  - The assignment of the analog span always comes after the assignment of the digital span.
  - The analog span always has 8 channels allocated, regardless of the number of FXO and/or FXS modules that are installed.
  - A single implied span exists for all populated and unpopulated analog ports.
  - Unpopulated analog ports occupy exactly 1 channel and go into the analog span.
  - As far as the analog span is concerned, BRI ports allocated by a BRI module are unpopulated ports.

    Note: This is extremely important to know when determining the channel assignment of your analog module(s) when a BRI module is installed in the first quad port (non-standard configuration).

- **Digital Spans for BRI**
  - A digital span will not exist if there are no BRI modules installed.
  - The assignment of a digital span always comes before the assignment of an analog span.
  - Four digital spans are dynamically created for each BRI module on the card (0, 4, or 8 total spans).
  - Digital spans always consist of 2 bchans (i.e. B Channels) and 1 hardhdlc channel (i.e. D Channel). The channels are allocated in that order.

Driver Configuration

You should have identified the type of Hx8 Series card when you received it. If you are not sure, refer to **Module Identification** on page 23 for assistance.

1. Begin by opening the **system.conf** file from the **/etc/dahdi** directory.

2. Specify the two letter country code for your loadzone and defaultzone. This will preload tone zone data and specify a default tone zone for your interfaces.

   The following is a typical setup for a telco in the United States:

   ```
   loadzone = us
   defaultzone = us
   ```

   The following is a typical setup for a telco in Spain:

   ```
   loadzone = es
   defaultzone = es
   ```

3. If your card has a blue BRI module, you will need to specify span maps, bchans (i.e. B Channels), and hardhdlc chans (D Channels) allocated to it in the **system.conf** file.

First, configure the span map for each BRI line. The span map includes defining the span number, timing, line build out, framing, and coding. Configuration details for each of these items is explained in this section.

```
span => <Number>,<Timing>,<Line Build
Out>,<Framing>,<Coding>[,Yellow][,TE|,NT][,Term]
```

Number:
This is the port that the BRI line is plugged into. Port 1 is the furthest span from the PCI connector. The port numbers are noted on the PCI bracket.

Timing:
This determines how timing is handled by the spans.

0 - Span provides its own timing (master clock)
1 - Receives timing from remote end (slave clock)
2 - Receives secondary backup timing from remote end (slave clock)
3 - Receives tertiary backup timing from remote end (slave clock)
4 - Receives quaternary backup timing from remote end (slave clock)
... and so on.

Note: Only one span per card can be defined to take timing, and that

defines timing for the rest of the card's spans. A setting of **0** should always be used when in NT mode.

Line Build Out:
For most setups the line build out is 0.

0: 0 db (CSU) / 0-133 feet (DSX-1)
1: 133-266 feet (DSX-1)
2: 266-399 feet (DSX-1)
3: 399-533 feet (DSX-1)
4: 533-655 feet (DSX-1)
5: -7.5db (CSU)
6: -15db (CSU)
7: -22.5db (CSU)

Framing:
BRI utilizes CCS framing.

Coding:
BRI utilizes AMI coding.

Yellow:
The optional yellow flag can be added at the end for transmitting a yellow alarm when no channels are open. For example, a yellow alarm will be transmitted when DAHDI is configured and initialized, but Asterisk is not running. Sending a yellow alarm is useful for the local side to notify the remote side that it is not ready to accept calls, and for determining which direction a communication problem exists

during troubleshooting. If this setting is unspecified and Asterisk is not running, DAHDI will not report an alarm and the remote side will think that the local side is ready to accept calls.

TE or NT:
Each of the BRI ports can be set for TE or NT mode independently. Specify **TE** to act as Terminal Equipment, or **NT** act as a Network Termination device. The default setting is TE mode.

There is a risk of electrical shock due to lightning when this device is utilized in TE mode. Take safety precautions when using the card in this manner.

Term (Termination):
Any BRI port can use 100 ohm termination. This should be enabled if the placement of an Hx8 Series card is the last in a daisy-chain. This is always the case when using PTP mode, and sometimes the case when using PTMP mode. Termination should be disabled only in instances where an Hx8 Series card's placement is inside of a daisy-chain. This is never the case when using PTP mode, and sometimes the case when using PTMP mode. The default setting is off. Examples are provided below.

NT (Term) <----> TE PTP (Term)
NT (Term) <----> TE PTMP (Term)
NT (Term) <----> TE PTMP (No Term) <----> TE PTMP (Term)

Note: If termination is not set appropriately, the D-Channel(s) may not remain stable.

Table 4: Common BRI Span Configurations

Mode	Card Position	Span Line
TE Point-to-Point	last in daisy-chain	span => 1,1,0,ccs,ami,te,term
TE Point-to-Multipoint	last in daisy-chain	span => 1,1,0,ccs,ami,te,term
TE Point-to-Multipoint	inside daisy-chain	span => 1,1,0,ccs,ami,te
NT Point-to-Point	last in daisy-chain	span => 1,0,0,ccs,ami,nt,term
NT Point-to-Multipoint	last in daisy-chain	span => 1,0,0,ccs,ami,nt,term

The following is a typical span map setup when connecting to a telco in Europe:

```
span => 1,1,0,ccs,ami,te,term
span => 2,2,0,ccs,ami,te,term
span => 3,3,0,ccs,ami,te,term
span => 4,4,0,ccs,ami,te,term
```

Then you will need to specify the channel definitions for each span.

The channel definition format is:

```
<device> = <channel list>
```

A list of valid devices are specified in the sample **system.conf** file. The devices that need to be specified for a BRI module are listed below.

```
bchan = 1,2,4,5,7,8,10,11
hardhdlc = 3,6,9,12
```

The bchan device specifies the bearer channels (B channels). The hardhdlc device specifies the delta channel (D channel).

Note: Unlike Digium's Digital T1/E1 cards, the device for the delta channel must be specified as hardhdlc instead of dchan. The Hx8 Series cards will not function properly if dchan is specified.

The combined configuration should look like the following:

```
loadzone = es
defaultzone = es

span => 1,1,0,ccs,ami,te,term
bchan = 1,2
hardhdlc = 3

span => 2,2,0,ccs,ami,te,term
bchan = 4,5
hardhdlc = 6

span => 3,3,0,ccs,ami,te,term
bchan = 7,8
hardhdlc = 9

span => 4,4,0,ccs,ami,te,term
bchan = 10,11
hardhdlc = 12
```

If your card has two BRI modules installed, the configuration should be specified as the following:

```
loadzone = es
defaultzone = es

span => 1,1,0,ccs,ami,te,term
bchan = 1,2
hardhdlc = 3

span => 2,2,0,ccs,ami,te,term
bchan = 4,5
```

```
hardhdlc = 6

span => 3,3,0,ccs,ami,te,term
bchan = 7,8
hardhdlc = 9

span => 4,4,0,ccs,ami,te,term
bchan = 10,11
hardhdlc = 12

span => 5,1,0,ccs,ami,te,term
bchan = 13,14
hardhdlc = 15

span => 6,2,0,ccs,ami,te,term
bchan = 16,17
hardhdlc = 18

span => 7,3,0,ccs,ami,te,term
bchan = 19,20
hardhdlc = 21

span => 8,4,0,ccs,ami,te,term
bchan = 22,23
hardhdlc = 24
```

4. If your card has a red quad FXO module, add the channel definitions for it to the **system.conf** file.

The channel definition format is:

```
<device> = <channel list>
```

A list of valid devices are specified in the sample **system.conf** file. The device that needs to be specified for an FXO module is listed below.

```
fxsks =
```

fxsks uses kewlstart signalling, which is loopstart signalling with disconnect supervision. For example, an Hx8 Series cards with only a quad FXO module installed would be configured as the following:

```
fxsks = 1-4
```

OR

```
fxsks = 1,2,3,4
```

If two quad FXO modules are installed, the configuration should be specified as the following:

```
fxsks = 1-8
```

OR

```
fxsks = 1,2,3,4,5,6,7,8
```

Note: The Hx8 Series cards do not support Ground Start signaling.

Note: An FXO module cannot be used in combination with a BRI module that is taking timing in TE mode on the same Hx8 Series card. An FXO module can be used in combination with a BRI module that is providing timing in NT mode on the same Hx8 Series card.

If a quad FXO module is installed on the first quad slot, and a BRI module is installed on the second quad slot, the configuration should be specified as the following:

```
loadzone=es
defaultzone=es

span => 1,0,0,ccs,ami,nt,term
bchan = 1,2
hardhdlc = 3

span => 2,0,0,ccs,ami,nt,term
bchan = 4,5
hardhdlc = 6

span => 3,0,0,ccs,ami,nt,term
bchan = 7,8
hardhdlc = 9
```

```
span => 4,0,0,ccs,ami,nt,term
bchan = 10,11
hardhdlc = 12

fxsks = 13-16
```

Note: The analog span begins at channel 13 instead of 1 because the assignment of an digital spans always comes before the assignment of an analog span. Please refer to the **Understanding Span and Channel Assignments** section for more details.

If a BRI module is installed on the first quad slot, and a quad FXO module is installed on the second quad slot, the configuration should be specified as the following:

```
loadzone=es
defaultzone=es

span => 1,0,0,ccs,ami,nt,term
bchan = 1,2
hardhdlc = 3

span => 2,0,0,ccs,ami,nt,term
bchan = 4,5
hardhdlc = 6
```

```
span => 3,0,0,ccs,ami,nt,term
bchan = 7,8
hardhdlc = 9

span => 4,0,0,ccs,ami,nt,term
bchan = 10,11
hardhdlc = 12

fxsks = 17-20
```

Note: The first four channels of the analog span (i.e. 13-16) are unallocated because the BRI module is installed on the first quad slot. As far as the analog span is concerned, BRI ports allocated by a BRI module are unpopulated ports. Please refer to the **Understanding Span and Channel Assignments** section for more details.

5. If your card has a green quad FXS module, add the channel definitions for it to the **system.conf** file.

The channel definition format is:

```
<device> = <channel list>
```

A list of valid devices are specified in the sample **system.conf** file. The device that needs to be specified for an FXS module is listed below.

```
fxoks =
```

fxoks uses kewlstart signalling, which is loopstart signalling with disconnect supervision. For example, an Hx8 Series cards with only a quad FXS module installed would be configured as the following:

```
fxoks = 1-4
```

OR

```
fxoks = 1,2,3,4
```

If two quad FXS modules are installed, the configuration should be specified as the following:

```
fxoks = 1-8
```

OR

```
fxoks = 1,2,3,4,5,6,7,8
```

Note: The Hx8 Series cards do not support Ground Start signaling.

If a quad FXS module is installed on the first quad slot, and a BRI module is installed on the second quad slot, the configuration should be specified as the following:

```
loadzone=es
defaultzone=es

span => 1,1,0,ccs,ami,te,term
bchan = 1,2
hardhdlc = 3

span => 2,2,0,ccs,ami,te,term
bchan = 4,5
hardhdlc = 6

span => 3,3,0,ccs,ami,te,term
bchan = 7,8
hardhdlc = 9

span => 4,4,0,ccs,ami,te,term
bchan = 10,11
hardhdlc = 12

fxoks = 13-16
```

Note: The analog span begins at channel 13 instead of 1 because the

assignment of an digital spans always comes before the assignment of an analog span. Please refer to the **Understanding Span and Channel Assignments** section for more details.

If a BRI module is installed on the first quad slot, and a quad FXS module is installed on the second quad slot, the configuration should be specified as the following:

```
loadzone=es
defaultzone=es

span => 1,1,0,ccs,ami,te,term
bchan = 1,2
hardhdlc = 3

span => 2,2,0,ccs,ami,te,term
bchan = 4,5
hardhdlc = 6

span => 3,3,0,ccs,ami,te,term
bchan = 7,8
hardhdlc = 9

span => 4,4,0,ccs,ami,te,term
bchan = 10,11
hardhdlc = 12

fxoks = 17-20
```

Note: The first four channels of the analog span (i.e. 13-16) are

unallocated because the BRI module is installed on the first quad slot. As far as the analog span is concerned, BRI ports allocated by a BRI module are unpopulated ports. Please refer to the **Understanding Span and Channel Assignments** section for more details.

6. DAHDI uses modular echo cancellers that are configured per channel. The echo cancellers are compiled and installed as part of the dahdi-linux package. You can specify the echo canceller to be used for each channel. If a hardware echo cancellation is not installed, the default behavior is for there to be no echo canceller on any channel. So, it is very important that you specify one in the **system.conf** file if you do not have hardware echo cancellers and need echo cancellation. The format is:

   ```
   echocanceller = <echocanceller name>,<channel(s)>
   ```

   A list of valid echo cancellers are specified in the sample **system.conf** file.

   The following is a typical setup using software-based echo cancellation:

   ```
   echocanceller = mg2,1-8
   ```

   Note: If a hardware echo-cancellation module is installed, please refer to **Configuring Card Features** on page 69 for information on configuring it.

7. Load DAHDI drivers into the kernel using the **modprobe** utility. The appropriate driver for the Hx8 Series cards is **wctdm24xxp**. Users should use the following modprobe command:

```
# modprobe wctdm24xxp
# dahdi_cfg -vv
```

Note: The Hx8 Series cards use the same driver as the TDM2400.

Configuring Card Features

You will need to modify the **chan_dahdi.conf** file which is located in the /etc/asterisk directory in order to configure the essential features of your card. This file is the configuration layer between DAHDI and Asterisk.

The signalling option will need to be set according to the type of module that you have installed and the line that you will be connecting to it. The following is a list of the most commonly used signalling types for an Hx8 Series card.

Table 5: Common Signalling Types

Signalling	Description	Module	Mode
bri_cpe	BRI CPE side using Point-to-Point	BRI	TE
bri_cpe_ptmp	BRI CPE side using Point-to-Multipoint	BRI	TE
bri_net	BRI NET side using Point-to-Point	BRI	NT
bri_net_ptmp	BRI NET side using Point-to-Multipoint *****	BRI	NT
fxs_ks	FXS Kewlstart with disconnect supervision	FXO	N/A
fxo_ks	FXO Kewlstart with disconnect supervision	FXS	N/A

* - NET PTMP requires libpri 1.4.11 (or later), Asterisk 1.8 (or later), and an externally powered ISDN phone. See Asterisk 1.8's sample chan_dahdi.conf for specific parameters and features.

A complete list of valid signalling types are specified in the sample **chan_dahdi.conf** file.

The following is a sample configuration for an Hx8 Series card with 1 quad FXS module and 1 BRI module. You can place this at the bottom of your **chan_dahdi.conf** file.

```
;General options
usecallerid = yes
hidecallerid = no
callwaiting = yes
threewaycalling = yes
transfer = yes
echocancel = yes
echocancelwhenbridged = yes
rxgain = 0.0
txgain = 0.0

;BRI Module
group = 1
signalling = bri_cpe
context = Incoming
channel => 1,2,4,5,7,8,10,11


;quad FXS Module
group = 2
signalling = fxo_ks
```

```
context = Internal
channel => 13-16
```

The following is a sample configuration for an Hx8 Series card with 1 quad FXO module and 1 BRI module. You can place this at the bottom of your **chan_dahdi.conf** file.

```
;General options
usecallerid = yes
hidecallerid = no
callwaiting = yes
threewaycalling = yes
transfer = yes
echocancel = yes
echocancelwhenbridged = yes
rxgain = 0.0
txgain = 0.0

;BRI Module
group = 1
signalling = bri_net
context = Incoming
channel => 1,2,4,5,7,8,10,11


;quad FXO Module
group = 2
signalling = fxs_ks
context = Incoming
channel => 13-16
```

Users of Digium's hardware echo cancellation module, the VPMOCT032, should set the echocancel option to "yes." The module will automatically configure itself to run at full capacity, 1024 taps (128ms), on each channel.

Users without the VPMOCT032 using open source echo cancellers included with DAHDI should configure echocancel to the values 32 (4ms), 64 (8ms), 128 (16ms), or 256 (32ms). Setting "yes" will default the option to 128 (16ms).

Users who have not purchased an Hx8 Series card with the hardware echo cancellation module are encouraged to take advantage of Digium's High Performance Echo Canceller software. This commercially licensed software, which is made available at no charge to in-warranty Digium analog interface card customers, provides toll quality echo cancellation, performed on the host CPU, at up to 1024 taps (128ms) per channel. For further details about HPEC, please refer to the Digium website here:

http://www.digium.com/en/products/software/hpec.php

When HPEC is enabled, users may set the value of the echocancel parameter to any of the following values:

128 - 16ms
256 - 32ms
512 - 64ms
1024 - 128ms

Note: Higher echocancel values will result in significantly increased CPU consumption. In order to optimize system performance, users are encouraged to choose the minimum value required to cancel their echo.

Voicemail

Open **voicemail.conf** and find the following line at the bottom:

```
[default]
1234 => 4242,Mark Spencer,root@localhost
```

In this example, **1234** is the mailbox number, **4242** is the password, **Mark Spencer** is the person's name, and **root@localhost** is his email address.

You can add extensions by adding the following:

```
1000 => 1234,Moose Member,moose@digium.com
2000 => 1234,Bill Savage,bsavage@digium.com
```

Dial Plan

Open **extensions.conf**, which contains a large, complex sample dial plan. In this step, you will configure a basic dial plan to enable you to send and receive calls.

If you are using an Hx8 Series card with 1 quad FXS module and 1 BRI module, go to the bottom of the file and add the following lines:

```
[Internal]
exten => 1000,1,Dial(DAHDI/13,20,rt)
exten => 1000,2,Voicemail(1000,u)
exten => 1000,102,Voicemail(1000,b)

exten => 2000,1,Dial(DAHDI/14,20,rt)
exten => 2000,2,Voicemail(2000,u)
exten => 2000,102,Voicemail(2000,b)

exten => 8500,1,VoiceMailMain
exten => 8501,1,MusicOnHold

exten => _9.,1,Dial(DAHDI/g2/www${EXTEN:1})
exten => _9.,2,Congestion

[Incoming]
exten => _X.,1,Answer
exten => _X.,2,Dial(DAHDI/g2,20,rt)
exten => _X.,3,Voicemail(1000,u)
exten => _X.,103,Voicemail(1000,b)
```

In this example, there are two internal extensions (1000 and 2000), a number to check voicemail (8500), a number to listen to music-on-hold, (8501), and a prefix to dial to get an outside line (9). It is configured to accept incoming calls over the BRI, rings phones 1 and 2, and route to voicemail box 1000.

If you are using an Hx8 Series card with 1 quad FXO module and 1 BRI module, go to the bottom of the file and add the following lines:

```
[Incoming]
exten => _X.,1,Answer
exten => _X.,2,Playback(demo-congrats)

exten => s,1,Answer
exten => s,2,Playback(demo-congrats)
```

In this example, it is configured to accept incoming calls over the BRI and FXO, and then playback a sound file.

Testing Your Configuration

1. Start Asterisk by typing:

   ```
   asterisk
   ```

2. Connect to Asterisk and view the output by typing:

   ```
   asterisk -vvvvr
   ```

3. Dial tone should be present on phones connected to the FXS ports. Test your configuration by placing an outgoing call, placing a call from extension 1 to 2, or receiving an incoming call. Successful completion of these tasks indicates your configuration is working properly.

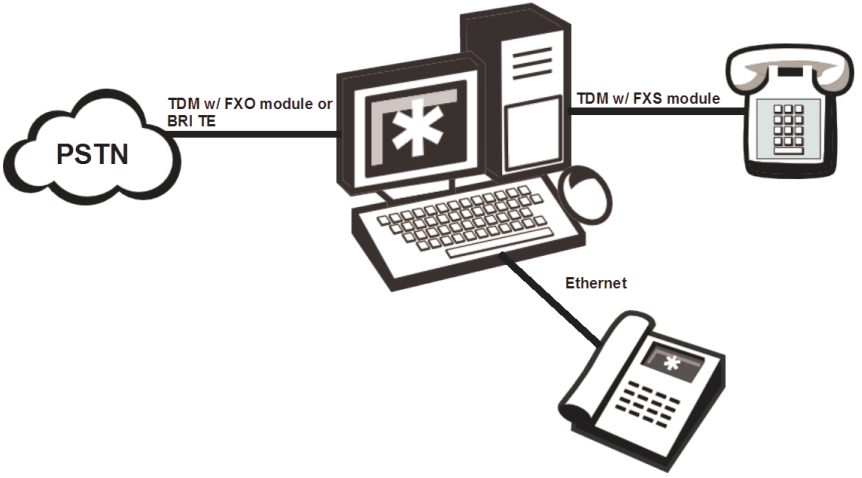


Figure 12: Sample Application

Note: More detailed information is provided at the Asterisk website (www.asterisk.org) and the Digium Knowledge Base (kb.digium.com).

Chapter 4
FXS, FXO, and BRI Explained

Identification

There are multiple configurations in which an Hx8 Series card may be purchased. Each configuration consists of a number of FXS, FXO, and/or BRI modules. These modules are identified by their color.

- **FXS** - Foreign Exchange Station (Green Modules)
- **FXO** - Foreign Exchange Office (Red Modules)
- **BRI** - Basic Rate ISDN (Blue Modules)

This chapter provides a review of the three module types and their uses within your Asterisk server.

> **Note:** Only qualified service personnel should install the card. Users should not attempt to perform this function themselves.

FXS Module

The FXS module allows an Hx8 Series card to initiate and send ringing voltage to an FXO device such as an analog telephone. Because of the modular design, you can activate additional ports at any time with more FXS daughter cards.

FXO Module

The FXO module allows an Hx8 Series card to terminate analog telephone lines (POTS). The FXO module passes all the call features any standard analog telephone line will support. The phone receiving the call

is the last FXO device in the chain. When it receives voltage from an FXS device, the phone rings. Because of the modular design, you can activate additional ports at any time with more FXO daughter cards.

BRI Module

The BRI module allows an Hx8 Series card to serve as Terminal Equipment (TE) or as a Network Termination (NT) device. When configured as an NT device, it can be the source of BRI lines or network end for servicing externally powered ISDN phones. Because of the modular design, you can activate additional ports at any time with more BRI daughter cards.

Using Your Hx8 Series Card

Connect an analog telephone line to an FXO port on your Asterisk server to receive voltage from the outside lines.

Connect the BRI line from the NT device to a BRI port on your Asterisk server to serve as Terminal Equipment.

Connect an analog phone to an FXS port on your Asterisk server. The recommended maximum distance from an FXS module to its connected device is 1,500 ft. (457m).

> **Note:** An analog phone line originating from an FXS module must remain inside the same building as the FXS module. In addition, an analog phone line originating from an FXS module must not be bundled with a line or lines that go outside the building where the FXS module is located.

Caution
FXS modules are not equipped with lightning protection and should not be exposed to high voltage. Lightning or high voltage can cause damage to an FXS module. Damage caused by lightning or high voltage will void the product warranty.

When the FXO module in your Asterisk Server receives ring voltage or when the BRI module receives a digital message notifying it of an inbound call , Asterisk will generate voltage using the FXS module to ring your analog phone.

Chapter 5
Troubleshooting

This chapter provides frequently asked questions and possible resolutions as identified by Digium Technical Support. Multiple resources are available to obtain more information about Asterisk and Digium products. Please visit both www.digium.com and www.asterisk.org for more information.

What do the statuses for BRI ports in dahdi_tool indicate?

- OK - The card is in-sync with the far end.
- YELLOW - The card is seeing the far end, but the far end is not seeing the card.
- RED - The card is not seeing the far end, the circuit is not up, or the cable is bad.

What type of cable do I need for BRI?

Digium recommends using the Digium BRI RJ11-to-RJ45 cables that are provided with each BRI module. The driver for the Hx8 Series cards will automatically swap the transmit and receive pins when going between TE and NT mode. This eliminates the need of using crossover cables. Refer to the pin assignments starting on page 88.

Which BRI protocol is used by the BRI module?

The BRI module supports the ETSI standard using CPE-PTP (Point-to-Point), CPE-PTMP (Point-to-Multipoint), NET-PTP (Point-to-Point), and NET-PTMP (Point-to-Multipoint).

Will the BRI module power an ISDN phone?

No, the BRI module will not provide power to an ISDN phone. An externally powered ISDN phone must be used when configured for NET-PTMP.

The FXO module never hangs up the line. How do I set it to hang-up?

Set **busydetect = yes** and **busycount = 10** in the **chan_dahdi.conf** for your channels. This will cause the line to hang-up by listening for a consecutive number of busy tones. Upon editing **chan_dahdi.conf**, you will need to restart Asterisk.

I have echo problems on my FXO modules and I've tried the different echo cancellation algorithms in dahdi_config.h, tried tweaking the gains, and still nothing works. What can I do?

Run the fxotune utility with the -i option (fxotune -i 4). It should discover which DAHDI channels are FXO modules and tune them accordingly. Be warned however, it takes a significant amount of time for each module to tune. A conservative estimate would be somewhere around 2-3 minutes for each module. You only have to tune the channels once for each line. The fxotune utility will store the calibration settings in /etc/fxotune.conf. You will need to configure your system to run fxotune with the -s flag

(fxotune -s) during the Linux boot sequence in order to initialize the previously discovered values which are stored in fxotune.conf. A recommendation is to put 'fxotune -s' in your distribution's startup scripts at some point after the DAHDI module loads and before Asterisk executes.

Note: The digit after the -i option is the DTMF digit that will break dialtone on the line.

There is a slight echo. How can I adjust the sound quality?

There are several options available to correct this when using software-based echo cancellation. Each involves editing the **chan_dahdi.conf** file. Be sure to restart Asterisk upon completion.

1. Adjust **echocancel = yes** to one of the following values: **32**, **64**, **128**, or **256**.
2. You can also set **echotraining = yes**.
3. You can also adjust the **rxgain** and the **txgain**, although it is only recommended to stay between **-5** and **5**. Otherwise, audio distortion and echo problems may arise.
4. If the problem persists, Digium recommends purchasing the VPMOCT032 hardware echo cancellation module. The VPMOCT032 may be combined with both the HA8 and HB8 card.

How can I enable more features?

To view all of the options available to add to your dial plan, type the following commands from within Asterisk:

```
*CLI> core show applications
*CLI> core show functions
```

Digium also offers services to help configure and add features you might need. Please refer to **Subscription Services Program** on page 87 for more information.

Common Fixes.

1. Check to see if the X Window System (*e.g.* X.Org Server) is running by entering the following:

   ```
   # ps aux | grep X
   ```

   If the X Window System is running, stop the application since it may cause a conflict with Asterisk.

2. Check to see if your PATA IDE hard drives are running with DMA levels set. Advanced users can perform an **hdparm** on their hard drive interface.

   Use hdparm with caution as the man page states that hard drive corruption can occur when using incorrect settings. Please review the man page for hdparm and make sure you understand the risks before using this tool.

   Check the current mode using this command:

   hdparm -vi /dev/[IDE Device**]**

   Use this command to set the drives into UDMA2 mode:

   hdparm -d 1 -X udma2 -c 3 /dev/[IDE Device**]**

Where can I find answers to additional questions?

There are several places to inquire for more information about Asterisk Digium products:

1. Digium Technical Support (+1.256.428.6161), or Toll Free in the U.S. (+1.877.344.4861), is available 7am-8pm Central Time (GMT -6), Monday - Friday. Please refer to **Free Installation Support** on page 87 for additional information on how to obtain assistance from Digium Technical Support.
2. Asterisk users mailing list (asterisk.org/lists.digium.com).
3. IRC channel **#asterisk** on (irc.freenode.net).

Free Installation Support

Digium hardware products include free installation support. In order to receive this support, register your Digium product using the serial number located on the serialization sticker of your Digium card.

Steps to receive installation support:

1. Record your product serial number.
2. Register your product at http://www.digium.com/register.
3. E-mail Digium Support via support@digium.com, or telephone via +1.256.428.6000 or Toll-Free +1.877.DIGIUM.1.

Note: Digium does not provide support for unregistered products.

Subscription Services Program

Digium is dedicated to supporting your Asterisk system by offering full technical support through our Subscription Services Program. Through this program, you can be at ease knowing that your business will always have access to the Asterisk experts. Pricing on Subscription Services may be obtained from your nearest reseller or you may call Digium Sales for referral to your nearest reseller at +1.256.428.6000 or send an e-mail to sales@digium.com

Appendix A
Pin Assignments

All eight ports on the Hx8 Series card's bracket are 6-pin RJ11 ports. The pin assignments when using an FXO or FXS module are identified in Table A-1. The pin assignments when using a BRI module are identified in Table A-2.

Table A-1: RJ11 Telco Port Connector for FXO/FXS

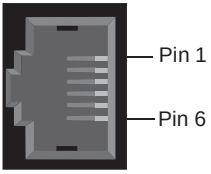
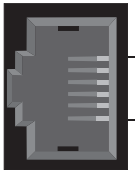
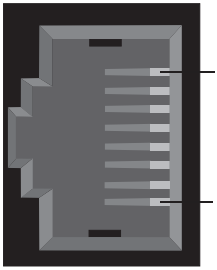
	Pin	FXO/FXS
	1	Not used
	2	Not used
	3	Tip
	4	Ring
	5	Not used
	6	Not used

Table A-2: RJ11 Telco Port Connector for BRI

	Pin	BRI TE	BRI NT
	1	Not used	Not used
	2	Tx-	Rx-
	3	Rx-	Tx-
	4	Rx+	Tx+
	5	Tx+	Rx+
	6	Not used	Not used

The Digium BRI RJ11-to-RJ45 cable will convert the pin assignments in Table A-2 to those identified in Table A-3 when using a BRI module.

Table A-3: RJ45 ISDN BRI S/T Port Connector

	Pin	BRI TE	BRI NT
	1	Unused	Unused
	2	Unused	Unused
	3	Tx+	Rx+
	4	Rx+	Tx+
	5	Rx-	Tx-
	6	Tx-	Rx-
	7	Unused	Unused
	8	Unused	Unused

Appendix B
Specifications

This appendix provides specifications, required environmental conditions, and maximum power consumption for the Hx8 Series cards.

Physical (All Cards).

Size: 6.54" × 4.2" × 0.68" (16.46 x 10.67 x 1.72 cm)
PCB size, does not include the PCI bracket.
Check your model carefully to be sure it will accept this PCI card.

Weight: 4.5 oz (127.58 gm) with no modules loaded
Each quad module adds 1 oz (28.35 g)

Interfaces.

Local Loop Access: Industry standard 6-pin RJ-11, ISDN S/T BRI RJ45

Note: FXS modules are not equipped with lightning protection and should not be exposed to high voltage. Lightning or high voltage can cause damage to an FXS module. Damage caused by lightning or high voltage will void the product warranty.

The recommended maximum distance from an FXS module to its connected device is 1,500 ft. (457m).

(HA8) - PCI Bus: 3.3V or 5V bus slot, half-length full-height PCI card, 33 MHz minimum bus speed, compliant with PCI 2.2 or greater. Additional Power: four-pin 12V connector for FXS power supply (required only if FXS modules are installed)

(HB8) - PCI-E X1, compliant with PCI-E X1 1.0 or greater.

Environment.

Temperature: 0 to 50° C (32 to 122° F) operation
-20 to 65° C (-4 to 149° F) storage
Humidity: 10 to 90% non-condensing

Note: Operating temperature is limited to 0 to 40° C (32 to 104°F) when used with optional PWR2400B Power Bracket

Hardware and Software Requirements.

500 MHz Pentium III or better
64MB RAM
Available PCI or PCI-Express Slot (as described previously)

Power Consumption.

The following table lists the power consumption for the primary components which can make up an HA8 and HB8 bundle.

Note: 3.3 and 5 volt power is taken from the PCI slot. 12 volt power is taken only from the four-pin hard disk drive connector or optional PWR2400B.

Table B-4: Maximum Power Consumption by Component

Component	3.3V PCI/ PCIe Power	12V HDD Power
HA8 Base Card	0.5W	0W
HB8 Base Card	1.5W	0W
X100M	0.25W	0W
X400M	0.5W	0W
S110M with 3 REN load	0.5W	2.5W
S110M with 5 REN load	0.5W	3.9W
S400M with four 3 REN loads	1.5W	11W
S400M with four 5 REN loads	1.5W	16.5W
B400M	0.25W	0W
VPMOCT032	1.5W	0W

The following table lists the maximum power consumption for two example bundles.

Table B-5: Maximum Power Consumption by Bundle

Bundle	Components	3.3V PCI/ PCIe Power	12V HDD Power
HA8-0010B with 3 REN load	Base Card 1 S110M module VPMOCT032	0.5W + 0.5W + 1.5W = *2.5W*	0W + 2.5W + 0W = *2.5W*
HB8-0404	Base Card 1 B400M module 1 X400M module	1.5W + 0.25W + 0.5W = *2.25W*	

Note: The maximum power consumption for additional bundles can be calculated by adding together the maximum power consumption for each component listed in Table B-4 that make up a particular bundle.

Appendix C
Glossary and Acronyms

ACD *Automatic Call Distribution*

A technology that distributes incoming calls to a specific group of devices that are associated to agents. Asterisk's Queue application performs automatic call distribution.

ANSI *American National Standards Institute*

An organization which proposes and establishes standards for international communications.

asynchronous

Not synchronized; not timed to an outside clock source. Transmission is controlled by start bits at the beginning and stop bits at the end of each character. Asynchronous communications are often found in internet access and remote office applications.

attenuation

The dissipation of a transmitted signal’s power as it travels over a wire.

bandwidth

The capacity to carry traffic. Higher bandwidth indicates the ability to transfer more data in a given time period.

bit

The smallest element of information in a digital system. A bit can be either a zero or a one.

bps *bits per second*

A measurement of transmission speed across a data connection.

BRI

Basic Rate ISDN

broadband

Broadband transmission shares the bandwidth of a particular medium (copper or fiber optic) to integrate multiple signals. The channels take up different frequencies on the cable, integrating voice, data, and video over one line.

channel

A generic term for an individual data stream. Service providers can use multiplexing techniques to transmit multiple channels over a common medium.

Cat5

Category of Performance for wiring and cabling. Cat 5 cabling support applications up to 100 MHz.

Cat5E

Category of Performance for wiring and cabling. Category 5 Enhanced wiring supports signal rates up to 100 MHz but adheres to stricter quality specifications.

CLEC *Competitive Local Exchange Carrier*

A term for telephone companies established after the Telecommunications Act of 1996 deregulated the LECs. CLECs compete with ILECs to offer local service. See also *LEC* and *ILEC*.

CO *Central Office*

The CO houses local switching equipment. All local access lines in a particular geographic area terminate at this facility (which is usually owned and operated by an ILEC).

CPE *Customer Premises Equipment*

Terminal equipment which is connected to the telecommunications network and which resides within the home or office of the customer. This includes telephones, modems, terminals, routers, and television set-top boxes.

DAHDI *Digium Asterisk Hardware Device Interface*

A telephony project dedicated to implementing a reasonable and affordable computer telephony platform into the world marketplace. In addition, the collective name for the Digium-provided drivers for Digium telephony interface products.

DS0 *Digital Signal, Level 0*

A voice grade channel of 64 kbps. The worldwide standard speed for digitizing voice conversation using PCM (Pulse Code Modulation).

DS1 *Digital Signal, Level 1*

1.544 Mbps in North America (T1) and Japan (J1) -up to 24 voice channels (DS0s), 2.048 Mbps in Europe (E1) - up to 32 voice channels (DS0s). DS1/T1/E1 lines are part of the PSTN.

DS3 *Digital Signal, Level 3*

T3 in North America and Japan, E3 in Europe. Up to 672 voice channels (DS0s). DS3/T3/E3 lines are not part of the PSTN.

DTMF *Dual Tone Multi-Frequency*

Push-button or touch tone dialing.

E1

The European equivalent of North American T1, transmits data at 2.048 Mbps, up to 32 channels (DS0s).

E3

The European equivalent of North American T3, transmits data at 34.368 Mbps, up to 512 channels (DS0s). Equivalent to 16 E1 lines.

EMI *Electromagnetic Interference*

Unwanted electrical noise.

full duplex

Data transmission in two directions simultaneously.

FXO *Foreign Exchange Office*

Receives the ringing voltage from an FXS device. Outside lines are connected to FXO ports.

FXS *Foreign Exchange Station*

Initiates and sends ringing voltage. Phones are connected to FXS ports.

G.711

A recommendation by the Telecommunication Standardization Sector (ITU-T) for an algorithm designed to transmit and receive mulaw PCM voice and A-law at a digital bit rate of 64 kbps.

G.723.1

A recommendation by the Telecommunication Standardization Sector (ITU-T) for an algorithm designed to transmit and receive audio at 6.3 kbps or 5.3 kbps.

G.729a

A recommendation by the Telecommunication Standardization Sector (ITU-T) for an algorithm designed to transmit and receive audio at 8 kbps.

H.323

A recommendation by the Telecommunication Standardization Sector (ITU-T) for multimedia communications over packet-based networks.

HDLC *High-Level Data Link Control*

A bit-oriented synchronous data link layer protocol developed by the International Organization for Standardization (ISO).

IAX *Inter-Asterisk eXchange*

The native VoIP protocol used by Asterisk. It is an IETF standard used to enable VoIP connections between Asterisk servers, and between servers and clients that also use the IAX protocol.

iLBC *internet Low Bitrate Codec*

A free speech codec used for voice over IP. It is designed for narrow band speech with a payload bitrate of 13.33 kbps (frame length = 30ms) and 15.2 kbps (frame length = 20ms).

ILEC *Incumbent Local Exchange Carrier*

The LECs that were the original carriers in the market prior to the entry of competition and therefore have the dominant position in the market.

interface

A point of contact between two systems, networks, or devices.

ISO *International Standards Organization*

IVR *Interactive Voice Menu*

An interactive technology that allows a telephone system to detect voice and keypad input.

LED *Light-emitting Diode*

Linux

A robust, feature-packed open source operating system based on Unix that remains freely available on the internet. It boasts dependability and offers a wide range of compatibility with hardware and software. Asterisk is supported exclusively on Linux.

loopback

A state in which the transmit signal is reversed back as the receive signal, typically by a far end network element.

MGCP *Media Gateway Control Protocol*

multiplexing

Transmitting multiple signals over a single line or channel. FDM (frequency division multiplexing) and TDM (time division multiplexing) are the two most common methods. FDM separates signals by dividing the data onto different carrier frequencies, and TDM separates signals by interleaving bits one after the other.

mux *multiplexer*

A device which transmits multiple signals over a single communications line or channel. See multiplexing.

NT *Network Termination*

A device connecting the customer's telephone or data equipment to the local ISDN exchange carrier's line. NT devices are connected to TE devices.

PBX *Private Branch Exchange*

A smaller version of a phone company's large central switching office. Example: Asterisk.

PCI *peripheral component interconnect*

A standard bus used in most computers to connect peripheral devices.

POP *Point of Presence*

The physical connection point between a network and a telephone network. A POP is usually a network node serving as the equivalent of a CO to a network service provider or an interexchange carrier.

POTS *Plain Old Telephone Service*

The public switched telephone network (PSTN) is the network of the world's public circuit-switched telephone networks. Originally a network of fixed-line analog telephone systems, the PSTN is now almost entirely digital, and now includes mobile as well as fixed telephones.

PPP *Point-to-Point Protocol*

Type of communications link that connects a single device to another single device, such as a remote terminal to a host computer.

PRI

Primary Rate ISDN

PSTN *Public Switched Telephone Network*

A communications network which uses telephones to establish connections between two points. Also referred to as the dial network.

PTMP *Point-to-Multipoint*

A connection where data is broadcast between more than two endpoints.

PTP *Point-to-Point*

A connection restricted to two endpoints.

PTT *Post, Telegraph, and Telephone*

The government agencies in many countries that traditionally operated and monopolized the public postal, telegraph, and telephone services.

QoS *Quality of Service*

A set of quality requirements for telephone service.

RBOC *Regional Bell Operating Companies*

The creation of Regional Bell Operating Companies were a result of AT&T's telephone monopoly being broken up in 1983.

REN *Ringer Equivalence Number*

An arbitrary value which denotes the electrical load a telephone ringer has on a line.

RJ11

A six-pin jack typically used for connecting telephones, modems, and fax machines in residential and business settings to PBX or the local telephone CO.

SIP *Session Initiation Protocol*

An IETF standard for setting up sessions between one or more clients. It is currently the leading signaling protocol for Voice over IP, gradually replacing H.323.

T1

A dedicated digital carrier facility which transmits up to 24 voice channels (DS0s) and transmits data at 1.544 Mbps. Commonly used to carry traffic to and from private business networks and ISPs.

T3

A dedicated digital carrier facility which consists of 28 T1 lines and transmits data at 44.736 Mbps. Equivalent to 672 voice channels (DS0s).

TDM *Time Division Multiplexer*

A device that supports simultaneous transmission of multiple data streams into a single high-speed data stream. TDM combines signals by interleaving bits one after the other.

TE *Terminal Equipment*

A device that is established as a point of termination of a communications circuit or channel. Terminal equipment comprises all customer premises equipment (CPE). TE devices are connected to NT devices.

telco

A generic name which refers to the telephone companies throughout the world, including RBOCs, LECs, and PTTs.

tip and ring

The standard termination on the two conductors of a telephone circuit; named after the physical appearance of the contact areas on the jack plug.

twisted pair

Two copper wires commonly used for telephony and data communications. The wires are wrapped loosely around each other to minimize radio frequency interference or interference from other pairs in the same bundle.

V *Volts*

VoIP *Voice over Internet Protocol*

Technology used for transmitting voice traffic over a data network using the Internet Protocol.